~~U.S. NUCLEAR REGULATORY COMMISSION~~

~~STANDARD REVIEW PLAN~~

~~OFFICE OF NUCLEAR REACTOR REGULATION~~

2.4.3 PROBABLE MAXIMUM FLOOD (PMF) ON STREAMS AND RIVERS

REVIEW RESPONSIBILITIES

Primary - ~~Hydrologic & Geotechnical Engineering Branch (HGEB)~~
Mechanical and Civil Engineering Branch (EMEB)

Secondary - None

I. AREAS OF REVIEW

In this section of the ~~safety analysis report (SAR)~~site safety assessment, the hydrometeorological design basis is developed to determine the extent of any flood protection required for those structures, systems, and components necessary to ensure the capability to shut down ~~the reactor~~ a nuclear power plant or plants of specified type that might be constructed on the proposed site and maintain it/them in a safe shutdown condition. The areas of review include the probable maximum precipitation (PMP) potential and precipitation losses over the applicable drainage area, the runoff response characteristics of the watershed, the accumulation of flood runoff through river channels and reservoirs, the estimate of the discharge rate trace (hydrograph) of the PMF at the plant site, the determination of PMF water level conditions at the site, and the evaluation of

coincident wind-generated wave conditions that could occur with the PMF. Included is a review of the details of design bases for site drainage (which is summarized in ~~SAR~~safety assessment Section 2.4.2); a review of the runoff for site drainage and drainage areas adjacent to the plant site, including the roofs of ~~planned~~ safety-related structures, resulting from potential PMP; and a review of the potential effects from erosion and sedimentation. The analyses involve modeling of physical rainfall and runoff processes to estimate the upper level of possible flood conditions adjacent to and on site.

Regulatory Guide 1.59 describes two positions with respect to flood protection for which a PMF estimate is required to determine the controlling design basis conditions. If Position 1 is chosen, all safety-related systems, structures, and components must be capable of withstanding the effects from the controlling flood design basis. Position 2 limits the review to specific safety-related structures, systems, and components necessary for cold shutdown and maintenance thereof.

II. ACCEPTANCE CRITERIA

Acceptance criteria for this ~~SRP~~ Standard Review Plan (SRP) section ~~is based on meeting the requirements of~~ relate to the following regulations:

~~1. General Design Criterion 2 (GDC 2) as it relates to structures, systems, and components important to safety being designed to withstand the effects of floods.~~

2. Regulations in 10 CFR Parts 52 and 100 as ~~it~~they relate~~s~~ to identifying and evaluating hydrologic features ~~characteristics~~ of the site.

~~USNRC STANDARD REVIEW PLAN~~

~~Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies.~~
~~Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.~~

~~Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.~~

~~Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.~~

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10 CFR Parts 52 and 100 require that a site's physical characteristics (including seismology, meteorology, geology, and hydrology) be taken into account when determining the acceptability of a site for a nuclear power reactor or reactors.

To satisfy the hydrologic requirements of 10 CFR Parts 52 and 100, the applicant's safety assessment must contain a description of the hydrologic characteristics of the site and region and an analysis of the PMF. This description must be sufficient to assess the acceptability of the site and the potential for those characteristics to influence the design of structures, systems, and components important to safety for a nuclear power plant or plants of specified type that might be constructed on the proposed site .

Meeting this requirement provides a level of assurance that structures, systems, and components important to safety for a nuclear power plant or plants of specified type that might be constructed on the proposed site could be designed to withstand hydrologic phenomena of severity up to and including the PMF.

Note: Though not required at the Early site permit stage, the applicant for a combined license (COL) will need to demonstrate compliance with General Design Criterion 2 as it relates to structures, systems, and components important to safety being designed to withstand the effects of floods.

To meet the requirements of the hydrologic aspects of ~~GDC 2 and~~ 10 CFR Parts 52 and 100, the following specific criteria are used:

The PMF as defined in Regulatory Guide 1.59 has been adopted as one of the conditions to be evaluated in establishing the applicable stream and river flooding design basis referred to in General Design Criterion 2, Appendix A, 10 CFR Part 50. PMF estimates are required for all adjacent streams or rivers and site drainage (including the consideration of PMP on the roofs of safety-related structures). The criteria for accepting the applicant's PMF-related design basis depend on one of the following three conditions:

1. The elevation attained by the PMF (with coincident wind waves) establishes a required protection level to be used in the design of the facility.

2. The elevation attained by the PMF (with coincident wind waves) is not controlling; the design basis flood protection level is established by another flood ~~phenomena~~ phenomenon (e.g., the probable maximum hurricane).

3. The site is "dry"; that is, the site is well above the elevation attained by a PMF (with coincident wind waves).

When condition 1 is applicable, the staff will assess the flood level (described in subsection III). The assessment may be made independently from basic data, by detailed review and checking of the applicant's analyses, or by comparison with estimates made by others that have been reviewed in detail. The applicant's estimates of the PMF level and the coincident wave action are acceptable if the estimates are no more than 5% less conservative than the staff's estimates. If the applicant's estimates of discharge are more than 5% less conservative than the staff's, the applicant should fully document and justify its estimates or accept the staff's estimates ~~and redesign applicable flood protection~~.

When conditions 2 or 3 apply, the staff analyses may be less rigorous (described in subsection III). For condition 2, acceptance is based on the protection level estimated for another flood-producing phenomenon exceeding the staff estimate of PMF water levels. For condition 3, the site grade must be well above the staff assessment of PMF water levels. The evaluation of the adequacy of the margin (difference in flood and site elevations) is generally a matter of engineering judgment. The judgment is based on the confidence in the flood level estimate and the degree of conservatism in each parameter used in the estimate.

Appropriate sections of the following documents are used by the staff to determine the acceptability of the applicant's data and analyses. Regulatory Guide 1.59 provides guidance for estimating the PMF design basis. Regulatory Guide 1.29 identifies the safety-related structures, systems, and components, and Regulatory Guide 1.102 describes acceptable flood protection to prevent the safety-related facilities from being adversely affected. Publications of the National Oceanic and Atmospheric Administration (NOAA) and the Corps of Engineers may be used to estimate PMF discharge and water level condition at the site and coincident wind-generated wave activity.

III. REVIEW PROCEDURES

Requirements and procedures governing issuance of early site permits for approval of proposed sites for nuclear power facilities are specified in 10 CFR Part 52. Information required for such a permit includes a description of the site's hydrometeorological characteristics. For this type of permit, the scope and level of detail for reviewing such data are outlined below.

For conditions 1 and 2 (described in subsection II), the methods used for evaluating flooding potential are separated into two parts--PMF on adjacent streams and local PMF. ~~The review procedure is outlined in the attached Figures 2.4.3-1 (for PMF on adjacent streams) and 2.4.3-2 (for local PMF).~~ (The procedure for evaluating the adequacy of site drainage facilities based on a local PMF is outlined in SRP Section 2.4.2.) Corps of Engineers PMF assessments for specific locations or generalized PMF assessments for a geographical area approved by the Chief of Engineers and contained in published or unpublished reports of that agency may be used in lieu of staff-developed analyses. In the absence of such assessments, both large and small basin PMP estimates by NOAA; published techniques of the World Meteorological Organization; and runoff, impoundment, and river-routing models of the Corps of Engineers are used by the staff to estimate PMF discharge and water level at the site. A comprehensive review of the applicant's analyses will be performed and a simplified analysis using calculational procedures or models with demonstrably conservative coefficients and assumptions is performed. If the applicant's PMF estimates are within acceptable margins (described in subsection II), the staff positions will indicate concurrence with the applicant's PMF estimates and the ~~SER~~ safety evaluation report (SER) input will be written accordingly. If the simplified analysis indicates a potential problem with the applicant's estimates, a detailed analysis using more realistic techniques will be performed. The staff will develop a position based on the detailed analysis; resolve, if possible, differences between the applicant's and staff's estimates of PMF design basis; and prepare the SER input accordingly.

Wind-generated wave action will be independently estimated using Corps of Engineers criteria such as the "Shore Protection

Manual." When sufficient water depth is available, the significant wave height and runup are used for structural design purposes, and the one percent wave height and runup are used for flood level estimates. Where depth limits wave height, the breaking or broken wave height and runup is used for both purposes.

For condition 3 (i.e., a "dry site"--one not subject to stream flooding by virtue of local topographic considerations), the following procedures apply:

1. Use Corps of Engineers PMF estimates for other sites in the region to develop "regional drainage area versus PMF discharge ~~(cubic feet per second/square mile)~~" (m^3 per sec/km^2 (ft^3 per sec/mi^2)) data, for extrapolation to the site.

2. Envelope the above data points to obtain an estimate of the PMF applicable to the site.

3. Increase the estimate based on a judgment as to the applicability of the basic estimates. An increase in the range of 10% to 50% is generally appropriate.

4. If warranted by relative elevation differences between the site and adjacent stream, estimate the flood level at the site using slope-area techniques or water surface profile computations.

5. Estimate wind (2-yr extreme windspeed) wave runup based on breaking or 1% wave heights. Criteria for estimating windspeed are discussed in ~~ANSI N170~~ ANSI/ANS-2.8-1992 and ~~Reference 17~~ References 16, 18, and 19.

6. Compare resultant water level with ~~proposed~~ plant grade and lowest safety-related facility that can be affected.

The above items of review are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For ~~construction permit (CP)~~ **early site permit** reviews, the findings will summarize the applicant's and staff's estimates of the peak PMF runoff rate and water level (including allowance for coincident wind-generated wave activity) at the site. If the applicant's estimates are within the criteria (described in subsection II), staff concurrence will be stated. If the staff's estimates are 5% more conservative than the applicant's estimates, if the flood conditions may adversely affect ~~the proposed~~ **a nuclear power** plant **or plants of specified type that might be constructed on the proposed site**, and if the applicant has been unable to support his estimates, a statement requiring use of the staff bases will be made. If the flood conditions do not constitute a design basis, the findings will so indicate.

~~For operating license (OL) reviews that have received detailed PMF reviews during the CP review, the CP conclusions will be referenced. Any flood potential not identified during the CP review will be noted.~~

If Regulatory Guide 1.59, Position 2, is elected by the applicant, a statement describing lesser design bases will be included in the findings with a staff conclusion of adequacy.

A sample statement for ~~a CP~~ **an early site permit** review follows:

> ~~The staff concludes that the plant flood design meets the requirements of General Design Criterion 2 and 10 CFR Part 100 and is acceptable. This conclusion is based on the following evaluation:~~
>
> ~~The~~ **As set forth above, the** probable maximum flood (PMF) resulting from the probable maximum precipitation (PMP) on the ABC River drainage basin yielded an estimated maximum stillwater level at **the planned location of** the intake structure on the D & E Canal of about ~~5.0 feet~~ **1.5 m** (5.0 ft) MSL~~, which is about 5 feet below its design flood level~~.
>
> The PMF resulting from a local PMP storm on the drainage basins for the small streams near the site yielded an estimated maximum stillwater level of about ~~60 feet~~ **18 m (**60

ft) MSL, which is about ~~20 feet~~ 6 m (20 ft) below plant grade.

The local PMF resulting from the estimated local PMP was found not to cause flooding of safety-related facilities for a nuclear power plant of type specified by the applicant that might be constructed on the proposed site, since the site drainage system ~~will~~ would be capable of functioning adequately during such a storm. Catch basins ~~will~~ would be provided as part of the storm drainage system and ~~will~~ would be located throughout the plant site to drain local areas. The plant yard ~~will~~ would be graded with gentle slopes away from high points at the plant buildings, and storm water ~~will~~ would drain away from the buildings into the local streams at lower elevations.

Historical data for the proposed site are consistent with the probable maximum precipitation and flood levels identified in the safety assessment.

Therefore, the staff concludes that the site meets the flood requirements of 10 CFR Parts 52 and 100 and is acceptable.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

This SRP section will be used by the staff when performing safety evaluations of early site permit applications submitted by applicants pursuant to 10 CFR Part 52. Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

In addition to the following specific references, Design Memoranda, Civil Works Investigations, and research and development reports of the Corps of Engineers and reports of other Federal and State agencies relevant to flood estimates at a specific site will be used on an "as-available" basis.

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 100, "Reactor Site Criteria."

3. Reports of the Corps of Engineers, Department of the Army:

EM 1110-2-1411, "Standard Project Flood Determinations," March 26, 1952 (rev. March 1965).

~~EC-1110-2-27, "Policies and Procedures Pertaining to Determination of Spillway Capacities and Freeboard Allowances for Dams," February 19, 1968.~~

EM 1110-2-1405, "Flood Hydrograph Analysis and Computations," August 31, 1959.

EM 1110-2-1408, "Routing of Floods Through River Channels," March 1, 1960.

EM 1110-2-1406, "Runoff from Snowmelt," ~~January 5, 1960.~~ March 31, 1998.

EM 1110-2-1603, "Hydraulic Design of Spillways," ~~March 31, 1965.~~ January 16, 1990.

EM 1110-2-1409, "Backwater Curves in River Channels," December 7, 1959.

Technical Bulletin No. 8, Sacramento District, "Generalized Snowmelt Runoff Frequencies," September 1962.

EM 1110-2-1601, "Hydraulic Design of Flood Control Channels," ~~July 1, 1970.~~ June 30, 1994.

EM 1110-2-1607, "Tidal Hydraulics," ~~August 2, 1965.~~ March 15, 1991.

~~CE 1308, “Stone Protection,” January 1948.~~

EM 1110-2-1410, "Interior Drainage of Leveed Urban Areas: Hydrology," May 3, 1965.

EM 1110-2-1413. "Hydrologic Analysis of Interior Areas," January 15, 1987.

EM 1110-2-1415, "Hydrologic Frequency Analysis," March 5, 1993.

EM 1110-2-1416, "River Hydraulics," October 15, 1993.

EM 1110-2-1417, "Flood Run-off Analysis," August 31, 1994.

EM 1110-2-1419. "Hydrologic Engineering Requirements for Flood Damage Reduction Studies," January 31, 1995.

~~Technical Report No. 4, Coastal Engineering Research Center, “Shore Protection, Planning, and Design” (1966) and “Shore Protection Manual” (1977).~~

CETA 79-1, "Wave Runup on Rough Slopes," CERC, July 1979.

Waterways Experiment Station, "Hydraulic Design Criteria," continuously updated.

~~TSP~~TM-37, "Riprap Stability on Earth Embankments Tested in Large and Small-Scale Wave Tanks," CERC, June 1972.

TP 78-2, "Reanalysis of Wave Runup on Structures and Beaches~~.~~," CERC, March 1978.

ETL 1110-2-120, "Additional Guidance for Riprap Channel Protection," May 1971.

ETL 1110-2-221, "Wave Runup and Wind Setup on Reservoir Embankments," November 1976.

ETL 1110-2-367. “Engineering and Design-Flood Hydrology," March 31, 1995.

"Shore Protection Manual." Coastal Engineering Research Center (CERC), 1984 or most recent edition.

"Coastal Engineering Manual," CERC, May 2002 or most recent edition.

4. Hydrometeorological Reports of the U.S. Weather Bureau (now U.S. Weather Service, NOAA) Hydrometeorological Branch:

   No. 1., "Maximum Possible Precipitation Over the Ompompanoosuc Basin above Union Village, Vt." (1943).

   No. 2., "Maximum Possible Precipitation over the Ohio River Basin above Pittsburgh, Pa." (1942).

   No. 3., "Maximum Possible Precipitation over the Sacramento Basin of California" (1943).

   No. 4., "Maximum Possible Precipitation over the Panama Canal Basin" (1943).

   No. 5., "Thunderstorm Rainfall" (1947).

   No. 6., "A Preliminary Report on the Probable Occurrence of Excessive Precipitation over Fort Supply Basin, Okla." (1938).

   No. 7., "Worst Probable Meteorological Condition on Mill Creek, Butler and Hamilton Counties, Ohio" (1937), unpublished. Supplement (1938).

   No. 8., "A Hydrometeorological Analysis of Possible Maximum Precipitation over St. Francis River Basin above Wappapello, Mo." (1938).

   No. 9., "A Report on the Possible Occurrence of Maximum Precipitation over White River Basin above Mud Mountain Dam Site, Wash." (1939).

   No. 10., "Maximum Possible Rainfall over the Arkansas River Basin above Caddoa Colo." (1939). Supplement (1939).

   No. 11., "A Preliminary Report on the Maximum Possible Precipitation over the Dorena, Cottage Grove, and Fern Ridge Basins in the Willamette Basin, Oreg." (1939).

No. 12., "Maximum Possible Precipitation over the Red River Basin above Denison, Tex." (1939).

No. 13., "A Report on the Maximum Possible Precipitation over Cherry Creek Basin in Colorado" (1940).

No. 14., "The Frequency of Flood-Producing Rainfall over the Pajaro River Basin in California" (1940).

No. 15., "A Report on Depth-Frequency Relations of Thunderstorm Rainfall on the Sevier Basin, Utah" (1941).

No. 16., "A Preliminary Report on the Maximum Possible Precipitation over the Potomac and Rappahannock River Basins" (1943).

No. 17., "Maximum Possible Precipitation over the Pecos Basin of New Mexico" (1944), unpublished.

No. 18., "Tentative Estimates of Maximum Possible Flood-Producing Meteorological Conditions in the Columbia River Basin" (1945).

No. 19., "Preliminary Report on Depth-Duration-Frequency Characteristics of Precipitation over the Muskingum Basin for 1- to 9-Week Periods" (1945).

No. 20., "An Estimate of Maximum Possible Flood-Producing Meteorological Conditions in the Missouri River Basin above Garrison Dam Site" (1945).

No. 21., "A Hydrometeorological Study of the Los Angeles Area" (1939).

No. 21A., "Preliminary Report on Maximum Possible Precipitation, Los Angeles Area, California" (1944).

No. 21B., "Revised Report on Maximum Possible Precipitation, Los Angeles Area California" (1945).

No 22 , "An Estimate of Maximum Possible Flood-Producing Meteorological Conditions in the Missouri River Basin Between Garrison and Fort Randall" (1946).

No. 23., "Generalized Estimates of Maximum Possible Precipitation over the United States East of the 105th Meridian, for Areas of 10, 200, and 500 Square Miles" (1947).

No. 24., "Maximum Possible Precipitation over the San Joaquin Basin, Calif." (1947).

No. 25., "Representative 12-Hour Dewpoints in Major United States Storms East of the Continental Divide" (1947).

No. 25A., "Representative 12-Hour Dewpoints in Major United States Storms East of the Continental Divide," 2nd edition (1949).

No. 26 , "Analysis of Winds over Lake Okeechobee during Tropical Storm of August 26-27, 1949" (1951).

No. 27., "Estimate of Maximum Possible Precipitation, Rio Grande Basin, Fort Quitman to Zapata" (1951).

No. 28., "Generalized Estimate of Maximum Possible Precipitation over New England and New York" (1952).

No. 29., "Seasonal Variation of the Standard Project Storm for Areas of 200 and 1,000 Square Miles East of the 105th Meridian" (1953).

No. 30., "Meteorology of Floods at St. Louis" (1953), unpublished.

No. 31., "Analysis and Synthesis of Hurricane Wind Patterns over Lake Okeechobee Florida" (1954).

No. 32., "Characteristics of United States Hurricanes Pertinent to Levee Design for Lake keechobee, Florida" (1954).

No. 33., "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24, and 48 Hours" (1956).

~~Draft Report, "All-Season Probable Maximum Precipitation, United States East of the 105th Meridian for Areas From 1,000 to 20,000 Square Miles and Durations From 6 to 72 Hours" (1972).~~

No. 34., "Meteorology of Flood-Producing Storms in the Mississippi River Basin" (1956).

No. 35., "Meteorology of Hypothetical Flood Sequences in the Mississippi River Basin" (1959).

No. 36., "Interim Report, Probable Maximum Precipitation in California" (1961), revised (1969).

No. 37., "Meteorology of Hydrologically Critical Storms in California" (1962).

No. 38., "Meteorology of Flood-Producing Storms in the Ohio River Basin" (1961).

No. 39., "Probable Maximum Precipitation in the Hawaiian Islands" (1963).

No. 40., "Probable Maximum Precipitation, Susquehanna River Drainage above Harrisburg, Pa." (1965).

No. 41., "Probable Maximum and TVA Precipitation over the Tennessee River Basin above Chattanooga" (1965).

No. 42., "Meteorological Conditions for the Probable Maximum Flood on the Yukon River above Rampart, Alaska" (1966).

No. 43., "Probable Maximum Precipitation, Northwest States" (1966, addendum 1981).

No. 44., "Probable Maximum Precipitation over South Platte River, Colorado, and Minnesota River, Minnesota" (1969).

No. 45., "Probable Maximum and TVA Precipitation for Tennessee River Basin up to 3,000 Square Miles in Area and Durations to 72 Hours" (1969).

No. 46., "Probable Maximum Precipitation, Mekong River Basin" (1970).

No. 47., "Meteorological Criteria for Extreme Floods for Four Basins in the Tennessee and Cumberland River Basins" (1973).

No. 48., "Probable Maximum Precipitation and Snowmelt Criteria for Red River of the North Above Pembinz, and Souris River Above Minot, North Dakota" (1973).

No. 49.. "Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages" (1977).

No. 50.. "The Meteorology of Important Rainstorms in the Colorado River and Great Basin Drainages" (1982).

No. 51.. "Probable Maximum Precipitation Estimates, United States East of 105th Meridian" (1978).

No. 52.. "Application of Probable Maximum Precipitation Estimates-United States East of the 105th Meridian" (1982).

No. 53.. "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates. United States East of the 105th Meridian" (1980). (NUREG/CR-1486)

No. 54.. "Probable Maximum Precipitation and Snowmelt Criteria for Southeast Alaska" (1983).

No. 55A.. "Probable Maximum Precipitation Estimates. - United States Between the Continental Divide and the 103rd Meridian." Hydrometeorological Report No. 55A. National Oceanic and Atmospheric Administration. I National Weather Service (Corps of Engineers and Bureau of Reclamation), June 1988.

No. 56.. "Probable Maximum and TVA Precipitation Estimates With Areal Distribution for Tennessee River Drainages Less Than 3,000 Square Mi in Area" (1986).

No. 57.. "Probable Maximum Precipitation - Pacific Northwest States. Columbia River (including portions of Canda), Snake River and Pacific Coastal Drainages " (1994).

No. 58.."Probable Maximum Precipitation for California, Calculation Procedures " (1998).

No. 59.. "Probable Maximum Precipitation for California ” (May 1999).

5. Technical Papers of the U.S. Weather Bureau (Now U.S. Weather Service, NOAA):

No. 2., "Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 207 First Order Stations," Rev. (1963).

No. 5., "Highest Persisting Dewpoints in the Western United States" (1948).

No. 10., "Mean Precipitable Water in the United States" (1949).

No. 13., "Mean Monthly and Annual Evaporation Data from Free Water Surface for the United States, Alaska, Hawaii, and the West Indies" (1950).

No. 14., "Tables of Precipitable Water and Other Factors for a Saturated Pseudo-Adiabatic Atmosphere" (1951).

No. 15., "Maximum Station Precipitation for 1, 2, 3, 6, 12, and 24 Hours": Part I: Utah (1951); Part II: Idaho (1951); Part III: Florida (1952); Part IV: Maryland, Delaware, and District of Columbia (1953); Part V: New Jersey (1953); Part VI: New England (1953); Part VII: South Carolina (1953); Part VIII: Virginia (1954); Part IX: Georgia (1954); Part X: New York (1954); Part XI: North Carolina (1955); Part XII: Oregon (1955); Part XIII: Kentucky (1955); Part XIV: Louisiana (1955); Part XV: Alabama (1955); Part XVI: Pennsylvania (1956); Part XVII: Mississippi (1956); Part XVIII: West Virginia (1956); Part XIX: Tennessee (1956); Part XX: Indiana (1956); Part XXI: Illinois (1958); Part XXII: Ohio (1958); Part XXIII: California (1959); Part XXIV: Texas (1959); Part XXV: Arkansas (1960); Part XXVI: Oklahoma (1961).

No. 16., "Maximum 24-Hour Precipitation in the United States" (1952).

No. 25., "Rainfall Intensity-Duration-Frequency Curves for Selected Stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico" (1955).

No. 28., "Rainfall Intensities for Local Drainage Design in Western United States for Durations of 20 Minutes to 24 Hours and 1- to 100-Year Return Periods" (1956).

No. 37., "Evaporation Maps for the United States" (1959).

No. 38., "Generalized Estimates of Probable Maximum Precipitation for the United States West of the 105th Meridian for Areas to 400 Square Miles and Durations to 24 Hours" (1960).

No. 40., "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years" (1961).

No. 42., "Generalized Estimates of Probable Maximum Precipitation and Rainfall-Frequency Data for Puerto Rico and Virgin Islands" (1961).

No. 43., "Rainfall-Frequency Atlas of the Hawaiian Islands for Areas to 200 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (1962).

No. 47., "Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska for Areas to 400 Square Miles, Durations to 24 Hours, and Return Periods from 1 to 100 Years" (1963).

No. 48., "Characteristics of the Hurricane Storm Surge" (1963).

6. Unpublished Hydrometeorological Reports of the U.S. Weather Bureau (now U.S. Weather Service, NOAA):

"Rappahannock River above Salem Church Dam Site, Va." (11/28/50).

"Potomac River, Va., Md., W. Va, (12 sub-basins)" (6/29/56).

“Delaware River above Trenton, Chestnut Hill, and Belvidere Dam Sites" (11/19/56).

"Delaware River above Tock's Island Dam Site" (12/16/65).

"St. John River above Dickey Dam Site, and Between Dicky and Lincoln School Dam Sites, Maine" (12/20/66).

"Coosa River above Howell Mill Shoals Dam Site, Ala." (3/3/50).

"Cape Fear River above Smiley Falls Dam Site, N.C." (11/16/50).

"Savannah River above Hartwell Dam Site, N.C." (1/5/51).

"Alabama and Apalachicola Rivers, Ala. and Fla." (3/19/52).

"Black Warrior River above Holt Lock Dam Site, Ala." (12/10/59).

"South Fork of Holston River above Boone Dam Site, Tenn." (8/14/50).

"Allegheny River above Allegheny River Reservoir, Pa." (9/28/56).

"Kentucky River, Ky. (2 basins)" (3/12/58).

"New River above Moores Ferry Dam Site, Va." (5/13/63).

"Licking River, Ky, and White River, Ind." (11/9/64).

"Iowa River above Coralville Dam Site, Iowa" (11/20/47).

"Des Moines River above Saylorville, Iowa and Howell Dam Site, Iowa" (3/19/48).

"Salt River, Mo." (1/21/55).

"James River above Jamestown Dam Site, N. Dak." (9/16/48).

"Big Blue River above Tuttle Creek Dam Site, Kans." (10/23/51).

"Republican River at (a) above proposed Milford Dam Site, Kans.; and (b) between Harlan Co. Dam and proposed Milford Dam Site, Kans." (11/24/58).

"Meramec River Basin, Missouri" (12/21/61).

"Republican River above Harlan Co. Res., Neb." (3/7/69).

"Canadian River above Eufaula Dam Site, Okla." (12/19/47).

"White River above Table Rock Dam Site, Mo." (3/19/48).

"Eleven Point River above Water Valley Dam Site, Ark." (3/19/48).

"Kiamichi River above Hugo Dam Site, Okla." (4/9/48).

"Boggy Creek above Boswell Dam Site, Okla." (4/9/48).

"North Canadian River above Optima (Hardesty) Dam Site, Okla." (12/22/49).

"Lower Canadian River, Okla." (6/10/48).

"Gaines Creek Dam Site, Okla." (5/13/48).

"Onapa-Canadian (combined) Dam Site, Okla." (5/13/48).

"Verdigris River above Oologah Dam Site, Okla." (5/4/50).

"Little Red River above Green Ferry, Ark." (7/24/50).

"Grand (Neosho) River above Strawn Dam Site, Kans." (11/14/51).

"Pinon Canyon above Trinidad, Colo." (4/10/52).

"Beaver Reservoir, White River, Ark." (12/1/55).

"Kisatchie Dam Site on Kisatchie Bayou, La." (3/1/56).

"Cypress Creek above Mooringsport, La." (8/27/56).

"Little River above at (a) Millwood Dam Site, Ark.; and (b) Broken Bow, Okla." (5/14/59).

"White River Drainage above Wolf Bayou, Ark." (3/31/66).

"Upper Arkansas River, Colorado (sub-basins)" (2/13/67).

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"Jemez Creek, N. Mex." (12/9/49).

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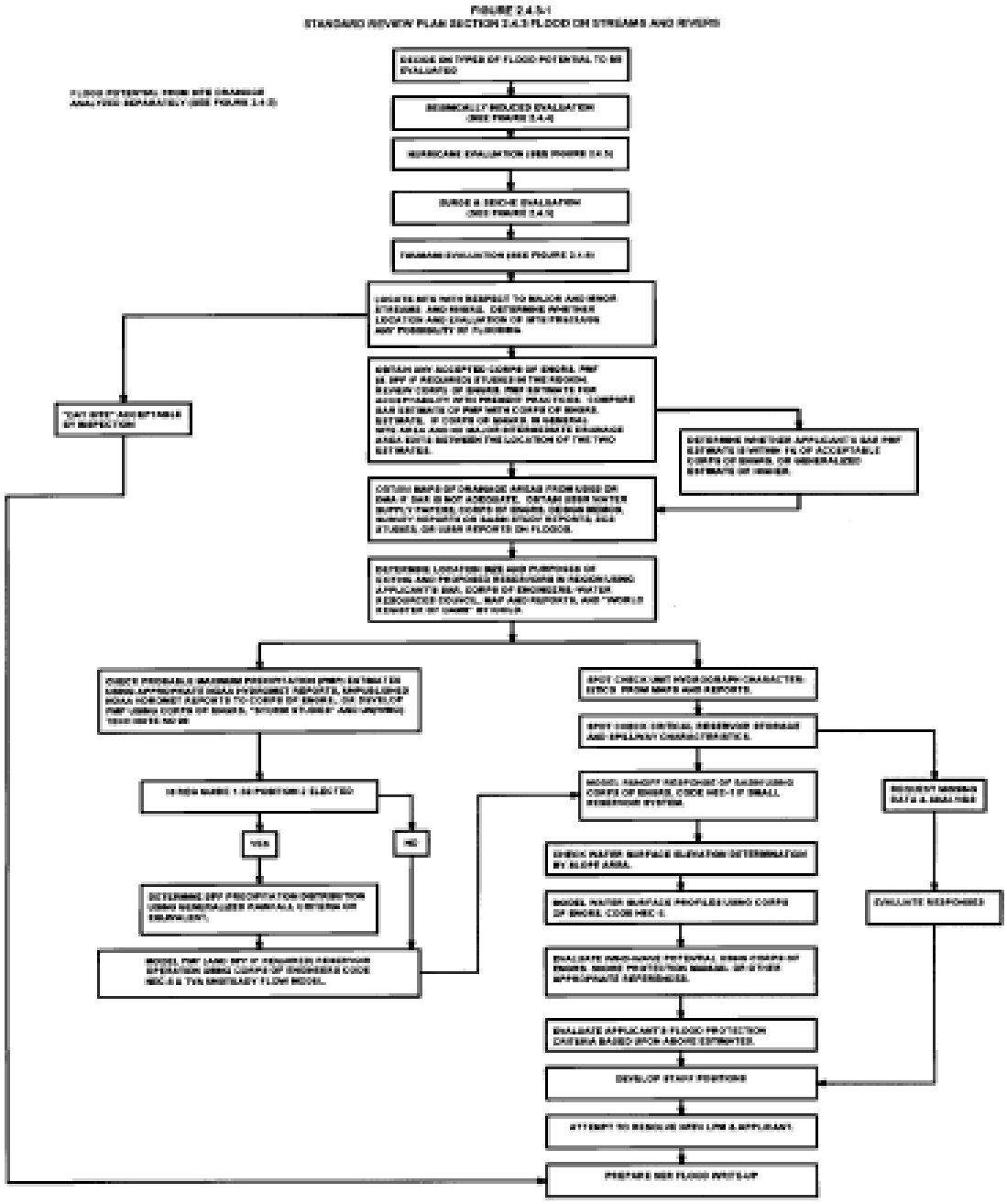

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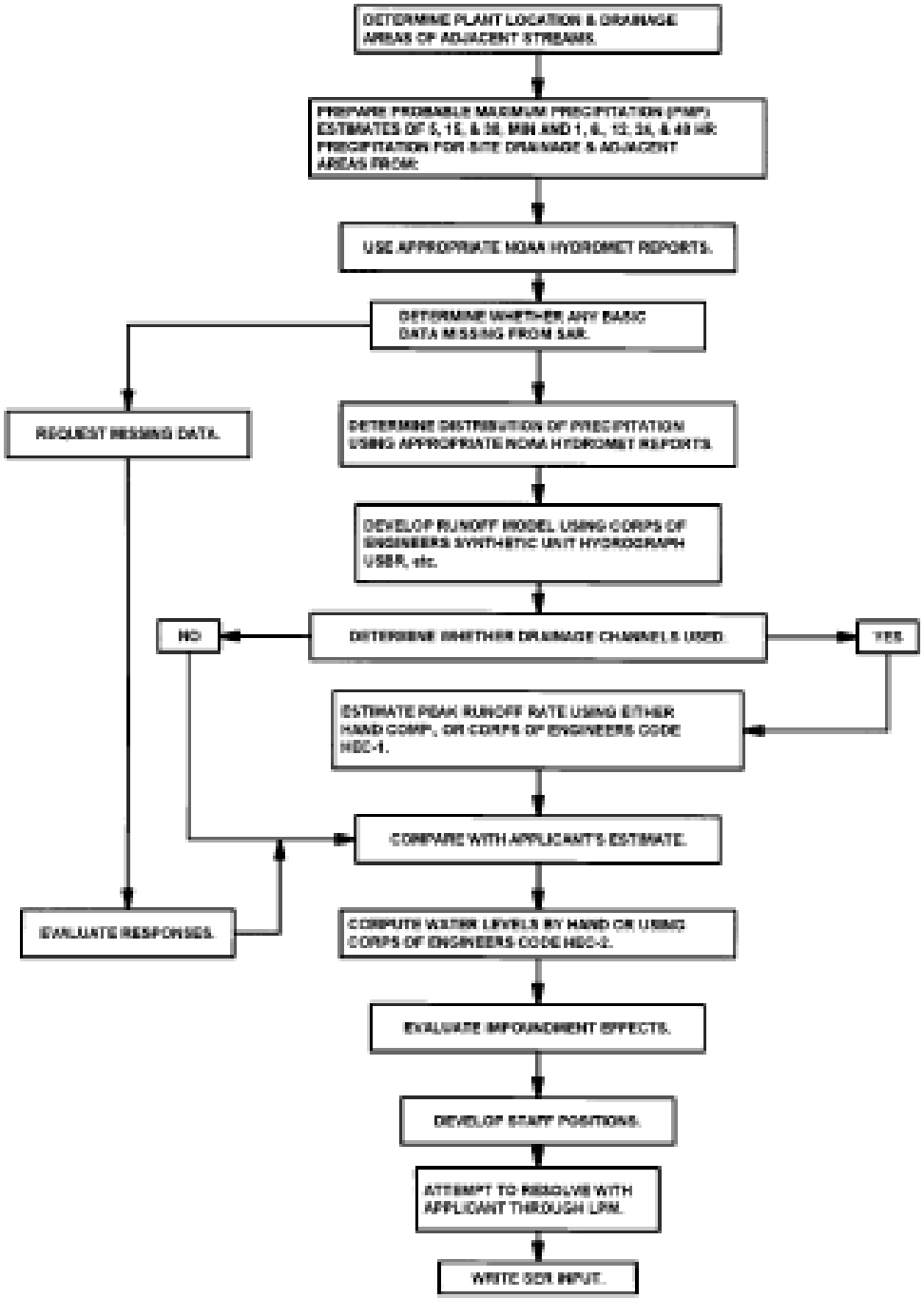
FIGURE 2.4.3-2
STANDARD REVIEW PLAN SECTION 2.4.3
SITE DRAINAGE AND ADJACENT DRAINAGE



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